Patient Safety in Adult Spinal Deformity Surgery

Current demographic changes mean there are now a higher number of patients with symptomatic adult deformity with increased expectations and a possibly unrealistic anticipation of what safely can be achieved. This article provides insight into the problems which may arise and what is currently being done to minimise these. Hopefully this may facilitate discussion between patients with a serendipitous finding of adult deformity and general orthopaedic surgeons about possible referral for a spinal deformity surgical opinion.

Ian Harding

Spinal surgery to correct deformity in adults is a significant surgical challenge with frequent complications, many of which have significant patient and financial consequences. Historically there has been a reluctance to embark upon surgery in the older population with spinal deformity, but modern medical and surgical techniques have improved patient safety and outcomes.\(^1,2\) Surgical rates vary considerably depending on resource availability as well as patient/cultural demands. Patient safety is an absolute priority in all aspects of spinal deformity surgery, both adult and paediatric, and has recently been the subject of two educational seminars by the Scoliosis Research Society (SRS)\(^3\) – an international organisation dedicated to the education, research and treatment of spinal deformity.

Patient safety is especially pertinent in adult spinal deformity surgery as the complication rate is approximately 40%.\(^4\) The SRS collects data on the three serious adverse outcomes of peri-operative death, blindness and neurological deficit. These are fortunately rare with most complications/re-operations occurring due to mechanical failure or infection.

The majority of deaths are of cardiac and respiratory origin, rising with age from 0.1% age 50-60 to 2.8% age 60-70 and 3.7% age 70-80.\(^5\) The prevalence of blindness in all spinal surgery is 0.094%\(^6\) and although not clearly defined does appear to be increased in adult deformity surgery. This is possibly due to prolonged surgery, blood loss and the need for low head positioning which should be avoided or limited as much as possible. The prognosis is dependent upon an early recognition, diagnosis and on whether there is a reversible cause.

Spinal cord injury has become much less common even in high risk groups with severe deformity because of the evolution of better neuro-monitoring techniques, such as evoked motor potentials, that provide sensitive real-time analysis of cord function. In a recent large series the use of intraoperative monitoring and protocols reduced a potential (based on historical expectation) 3.1% incidence of neurological deficit to 0.13%.\(^7\) Patient safety algorithms continue to be developed to aid the surgeon intra-operatively in the event of monitoring abnormalities. A key requirement for monitoring is to maintain an adequate mean arterial pressure for that specific patient (which needs careful anaesthetic consideration) that is as low as possible to limit blood loss and transfusion requirement. Limiting blood loss is improved by better patient positioning, reduced operative time, minimally invasive surgery, local haemostatic agents (gelatin-thrombin matrix), systemic pharmacological agents (e.g. tranexamic acid) and cell saver\(^8\) and is in itself a key patient safety factor.

Thrombosis (and embolism) is much less common (1.09% deep vein thrombosis, 0.06% pulmonary embolism)\(^9\) than in hip surgery and appropriate prophylaxis requires individual and iterative consideration given the potential for continuing postoperative loss from raw fusion sites and the risk of compressive haematoma in the canal.

In contrast, deep infection is much more frequent (3-5%) than in primary hip surgery.\(^10\) Treatment can be difficult and it is usually preferable to keep metalwork in situ until fusion has occurred. Bacteriological culture is imperative. It is usually preferable to delay commencing antibiotics until positive cultures and sensitivities are available.

Given this background, an overriding consideration is whether any specific patient will see overall benefit from the intended surgical procedure.
This is decided upon by careful history with particular attention to:
• the location type and severity of pain and neurological symptoms and potential for improvement
• the consequent disability, whether interfering with activities the patient needs to do, rather than would like to be able to do
• whether there has been a trial of appropriate conservative modalities of treatment and the response to these

Examination:
• including assessment of usual coronal and sagittal spinal balance and spinal mobility
• neurological assessment

Imaging to include:
• full length standing x-rays with stress views
• MRI and CT with 3D reconstruction
• DEXA scans (Severe osteoporosis may preclude any or many surgical options)
• selective nerve root blocks to identify symptomatic areas of neural compromise

The case should be presented to a multi-disciplinary team meeting with appropriate expertise taking into account the current presentation and potential for future deterioration if left untreated, with second opinions being sought if necessary, the most important decision being whether or not to offer surgery at all.

If the patient has intimated that they might wish to consider surgery and it is concluded he/she might benefit, the patient safety algorithm starts with a clear explanation of the goals and risks involved to facilitate true informed consent. A systems based approach has been proposed to reduce peri-operative complications to patients in a true multidisciplinary environment\textsuperscript{11}, an approach mimicked in many other centres when treating high risk patients\textsuperscript{12}.

Specific surgical factors include careful pre-operative planning with particular attention to:
• level selection
• sagittal profile
• whether or not an osteotomy should be performed
• operative approach (anterior, posterior or combined – simultaneous or staged)
• type of instrumentation
• whether or not pelvic fixation technique is needed

An increasingly common practice is to have a second senior surgeon performing surgery when the case is very complex, such as an osteotomy, potentially to reduce the risk of complications, although this has yet to be formally evaluated.

Better surgical techniques have led to improved deformity correction and fusion rates with reduced complications from sagittal or coronal imbalance, incomplete correction, failure of fusion (pseudarthrosis) and implant failure (breakage, loosening, migration). Pseudarthrosis is more common in smokers and when there is marked residual sagittal imbalance/maisalignment. Careful surgical planning with attention to the sagittal plane and the specific techniques to be employed are therefore mandatory. Software is available to facilitate this and obtaining good sagittal alignment has subsequently been shown to improve patient outcomes\textsuperscript{13}. However, the potentially better outcomes from osteotomies\textsuperscript{14}, which have recently become more popular, expose the patient to an increased risk of pseudarthrosis, blood loss, and neurological deficit.

Solid implant fixation is a particular challenge in the elderly patient but becomes even more pertinent when the spine is destabilised by osteotomy and excellent fixation is required proximally and distally. Modern pedicle screw systems, interbody cages, robotic positioning of screws, image guidance and specialised pelvic fixation\textsuperscript{15,16,17} facilitate this but it remains a challenge in thin patients with poor bone stock who may suffer with prominent metalwork and/or implant loosening. In patients with a low bone density, surgery may be inadvisable and although cement augmentation techniques and HA coated screws are now available; their potential improved efficacy is as yet unproven.

The biggest challenge in improving patient safety in adult deformity surgery is ensuring the comprehensive and accurate collection of data, including patient related outcomes and complication rates. The British Spine Registry\textsuperscript{18} is a growing resource which has been developed to improve patient safety and monitor the results of spinal surgery, which will hopefully define the most effective and safest interventions. Currently data entry is voluntary and although surgical risk can never be eliminated hopefully complications will continue to be reduced by patient safety initiatives facilitated by integrated and improving multi-disciplinary working and the combined efforts of the spinal societies and spinal deformity surgeons.

Ian Harding is a Consultant Orthopaedic Surgeon in Bristol with a specialist interest in spinal deformity surgery. He completed his fellowship at the Institut Calot in France. Research interests include spinal sagittal alignment and disc degeneration.

Correspondence:
Email: ian.harding@nbt.nhs.uk

References can be found online at www.boa.ac.uk/publications/JTO or by scanning the QR Code.